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BIOCHRONOLOGY OF LARGE MAMMALS IN THE EARLY AND MIDDLE PLEISTOCENE OF THE ITALIAN PENINSULA

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ABSTRACT - During the Plio-Pleistocene. sharp important changes in the large mammal assemblages of the Italian Peninsula are not clearly recognizable. Sometimes, a progressive and gradual renewal can be obscrvcd, either due to local evolution of pre-existing forms or by recurrent immigrations from Asia or Central Europe. The renewal phases arc probably related to climatic fluctuations. An accceleration of this phenomenon may be noticed in concurrence to the major climatic crises. Under these conditions, and taking into account that the response of single taxa to climatic and environmental variations is neither uniform nor contemporary. it is very difficult. if not impossible. to fix a limit between two faunal units. In the case of the "Villafranchian"/"Galcrian" faunal transition in Italy. there are **at** least three possible hypotheses: **a)** the transition can be considered to have happened more or lcss at the lower Pleistocene/Midle Pleistocene boundary: b) institution of the new Mammal Age, the Protogalerian. which covers the Early Pleistocene before the Great Glacial. It is charactcrizcd by the progressive appearance of "Galcrian" taxa and by persistence of the arvicolids of the *Microtus (Allophaiomys)* subgenus; c) the transition between Villafranchian and Galcrian faunas can be established conventionally e.g. at tlie first appearence in Italy of *Megaceroides verticornis*.

Key words: Biochronology, Mammalia. Early and Middle Pleistocene, Italy.

INTRODUCTION

The biochronology of the mammalofaunas of the Early and Middle Pleistocene is based on recognition of bioevents which determine a progrcssive renewal of the assemblages either by evolution of pre-existent taxa or by the appearancc of immigrants. The subdivision in Mammal Ages and Faunal Units is made on the grounds of turnover phases, which should include a lot of biocvents. However. the increase in data and the discovery of new faunas tend to emphasize how in Italy, in the course of the Pleistocene. thc pronounced faunal turnovers which involved a great number of taxa were not frequent. This increase in data also demonstrates that single bioevents are more or less separated and that renewal tended to be progressive. The settings of precise limits of the biochrons is still impossible. At best, faunal complexes can be characterized only on the basis of their global composition and evolutive degree and within a certain timespan. In fact it is impossible to define the precisc moment of the transition between them.

Ten Faunal Units can be identified in the large mammal faunas of the Early and Middle Italian Pleistocene: Olivola, Tasso, Farneta. Pirro and Colle Curti for the Early Plcistocene: Slivia, Isernia and Fontana Ranuccio for the middle Early Pleistocene, Torre in Pietra and Vitinia for the middle Late Pleistocene (Table 1) (cf. Caloi and Palombo, 1995 with bibliography; in press; Caloi et *al.*. in press).

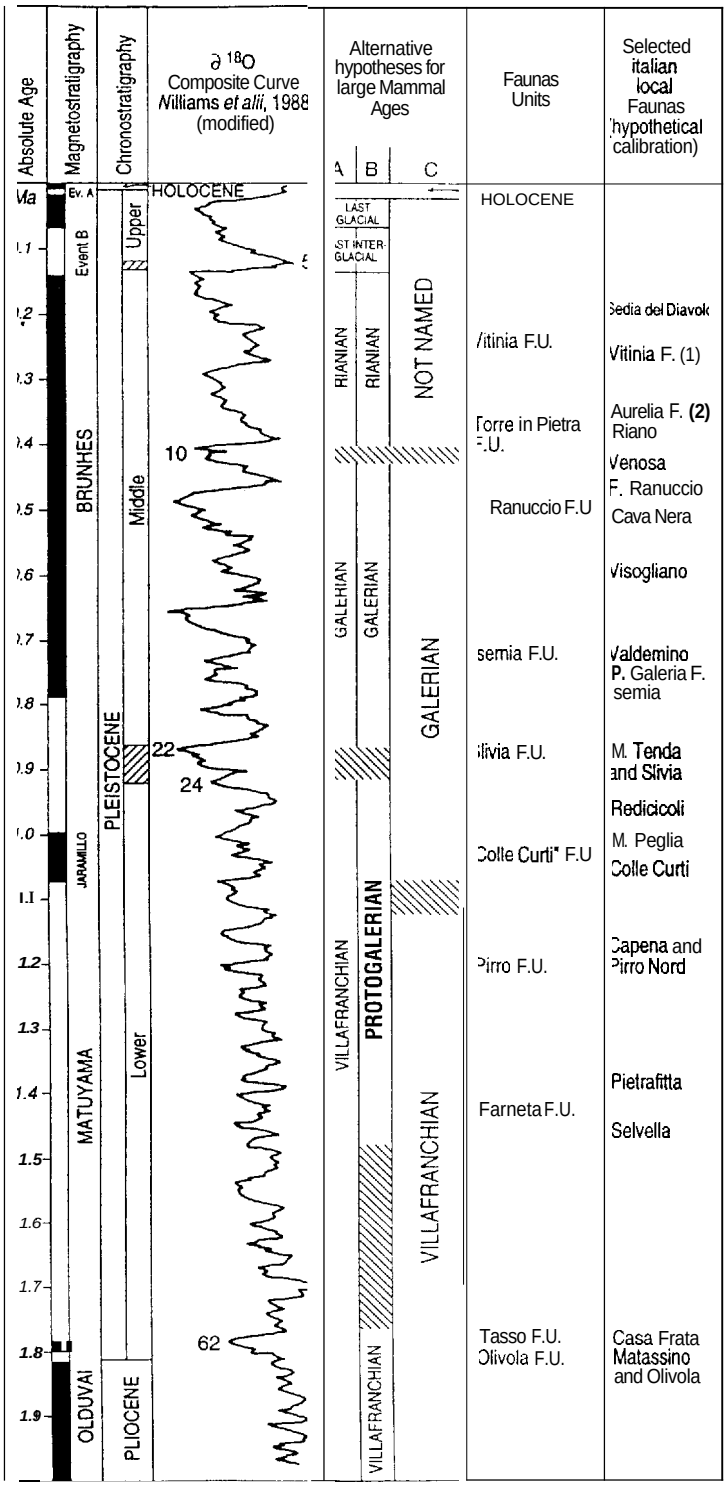


Table 1 - Tentative correlation chart of stratigraphic, paleomagnetic and isotopic data with subdivision for the Italian peninsula mammalian faunas of the Early and Middle Pleistocene.
(1) sites of Vitinia F. and correlatable ones: Vitinia (beds e), Torre in Pietra (upper beds), Sedia del Diavolo, Monte delle Gioie, via Flaminia etc. (Caloi et al. in press)
(2) sites of Aurelia F. and correlatable ones: Torre in Pietra (lower beds), Malagrotta, La Polledrara, Castel di Guido, Riano etc. (Caloi et al. in press)

DISCUSSION

With the associations of the Olivola F.U. (Table 1) (bottom of the Pleistocene, paleomagnetic calibration of the Matassino fauna with a short reversal at the top of Olduvai subchron. Torre et al.. 1993 and personal communication), a considerable faunistical renewal took place both for the number of new forms and extinctions (Table 2), in correspondence with the transition between Middle and Late Villafranchian. However. the modality and time of realization of this renewal are unknown, because there are no calibrations for the assemblage of Costa S. Giacomo (Bidditu et al.. 1979) (1), which biochronologically preceded it. whose elements from the Middle Villafranchian are present. as well as taxa which characterize the Late Villafranchian. A truly rapid renewal, characterised by a still more intense faunistical change. took place with the transition to local fauna of Casa Frata (Tasso F. U.) (Table 1) (Borselli et al., 1980), calibrated paleomagnetically with the top of Olduvai subchron (Torre et al., 1993), and thus more recent than the local fauna of Matassino by a few thousand years. Considering the two units, the main extinctions (at least 13. 4 for Olivola and 9 for **Tasso)** and new appearances (at least 16, 7 and 9 respectively) relative to the bioevents, which lead to the constitution of the associations of the Olivola and Tasso F. U.. determine a considerable change in the world of large mammals, which more or less coincides with peaks in arid, relatively cold climate, probably relatable to the end of the Tiglian and the early phases of the Eburonian (Bertini, 1990: Zagwin, 1992). The faunistical variations which characterise the Tasso F. U. could be connected up with the spread of steppes with *Artemisia* in Southern Italy (Combourieu-Nebout and Vergnaud Grazzini, 1991, stages 62 - 50).

The passage to the following F. U. (Farneta F. **U.)** (Table 1) is characterized not only by a large number of extinctions but also by the appearance of new immigrants, among which an early nucleus of "Galerian" forms. Some of the pre-existent taxa are represented by more advanced forms (Table 2). Due to the lack of absolute chronological data or paleomagnetical calibrations, modalities and times cannot be defined exactly. Considering the composition of the single assemblages of the Farneta F. U., it is, however. possible to observe how the local fauna of Selvella (Azzaroli and Mazza. 1992; De Giuli. 1987; Masini et al.. 1994) appears to be less renewed than that of Pietrafitta (Ambrosetti et al., 1987; Ambrosetti et al., in preparation; Rustioni and Mazza, 1991), in which an arcaic megacerine of the group of *Megaceroides verticornis*, *M. obscurus* (2). is present and among micromammals, *Microtus chalinei*, *Mimomys pusillus* and arvicolids related to *M. (Allophaiomys) ruffoi* are reported. Within the Farneta F. U. an example of renewal could thus be found. with bioevents being not wholly synchronous. The end of this F.U. is Characterized by a large number of extinctions.

A long period follows, in which changes in the faunal associations, though not very numerically significant, lead to an increase in "Galerian" forms. The change that characterizes the local faunas of Pirro (whose exact chronostratigraphical position is unknown) (De Giuli and Torre, 1984; De Giuli et al., 1987: De Giuli et al., 1990; Masini and Santini, 1991; Masini and Torre, 1990) and of Colle Curti (Table1), calibrated with the bottom of the Jaramillo event (Albianelli et al., 1993) (Borselli et al.. 1988; Ficcarelli and Mazza, 1990; Ficcarelli et al.. 1990; Ficcarelli and Silvestrini, 1991; Masini et al., 1994), is of lesser entity: four new forms occur and the extinctions prevail (Table 2). This could be related to a different type of environmental stimulus. In this period. as a matter of fact, the fluctuations of the glacial delta ^{18}O have lower values than the preceding ones and are characterized by short and uniform glacial/inter-

glacial cycles (about 50,000 years) (stages 63-25; Williams et al.. 1988). Furthermore, according to Vergnaud Grazzini et al. (1990). in stage 28 there is already a tendency to increase the glacial delta ^{18}O value and thus a colder climatic fluctuation than the pi-eccding ones appeared around the time of the Jaramillo event. As we have seen. it is in this lapse of time that the nucleus of the so-called "Galcrian Fauna" begins to take shape. Therefore, it could be hypothesized that the progressive settling to relatively arid and cooler climatic conditions: which happened during all the lower Pleistocene, favoured the southward spread of the forins suited to open spaces. These forms reached our peninsula at different times.

The considerable faunal renewal that can he recognized in the Slivia F. U. (Table 1) may well coincide with the climatical crisis of the Great Glacial Age (stages 24/22). which was accompanied by *a* variation in the type of cycles. They became more irregular in duration and intensity (Williams et al., 1988). In the local faunas of Slivia and Monte Tenda (Ambrosetti et al.. 1979; Masini et al., 1994); Di Stefano and Petronio, 1992), more or less correlatable to each other, the appearance of a consistent number of forms can be noticed (12 new occurrences) (Table2), which are generally characterized, in the case of large herbivores, by the large size and advanced characters. In the case of the large mammals, this renewal is accompanied by a low number of extinctions. Among the micromammals. the replaccmcnt of *Allophaiomys* by *Microtus* and the appearance of *Allocricetus bursae* are also significant. The renewal of the faunas may have been completed during a 200.000-250.000 year span. as indicated by the associations of the Isernia F. **U.** (dated at over 736.000 years, Coltorti et al., 1982), which is characterized by a thriving contingent of new forms (11 new occurrencesj. but by few extinctions between Slivia and Isernia F. U., while the forms of the Late Villafranchian are at this stage much reduced. **All** the same, also in this case. data for an exact chronostratigraphical insertion of the associations are lacking. The entity of the timespan between the Colle Curti and Slivia F. U. is unknown (Table 1), because the correlation of the Slivia F. U. at the beginning of the Great Glacial Age is based only on the type of assemblage; besides. the dating of the archeological level of Isernia is yet to be confirmed, since *Arvicola cantiana*, found here, appears later in the rest of Europe (cf. Kolfschoten. 1992). The consistent faunal renewal at the beginning of the mid-Plcistocene. documented by the Slivia and Isernia F. U., could therefore have been realized over a relatively long period of time.

With the local fauna of Fontana Ranuccio (Table 1), dated at 458,000 years (Riddittu et al.. 1979), the extinctions lead to the disappearance of the Villafranchian survivors (some following survivals are questionable) (Table 2); the appearances arc limited in number but they contribute to the establishment of a more modern fauna. In this period, in which the glacial values accentuate (500,000 - 400.000 years, Thunell et al.. 1990), there is ***a*** rarification or disappearance of the surviving tertiary flora. Some forms persist on for a little time afterwards as relicts on the Italian peninsula (Follieri et al.. 1986; Follieri et al., 1988).

Another faunal renewal characterized the Torre in Pietra and Vitinia F. U. (Table 1). Considering these F. U. together. at least 9 new taxa appear (between species and more advanced subspecies), while 7 forms disappeared in the transition between Fontana Ranuccio and Torre in Pietra F.U There were only two extinctions in the passage to Torre in Pictra and Vitinia F.U.. In the associations of these units. several elements which belong to recent or current Italian fauna are present. The renewal conies about in a period of time (stages 9 and 7) in which. in the Mediterranean environment,

the climatical curve moves towards higher temperatures (Vergnaud Grazzini et al.. 1990)and some Senegalese molluscs appear in the Mediterranean, as well as "warm" ostracoda and foraminifera (Glioazi. 1990). The climatic conditions become milder. with phenomena of deglaciation and climatic conditions which reach their acme in substage 5e.

CONCLUSIONS

During the Pleistocene, the main renewal phases of mammalofaunas seem to coincide with time periods in which important climatical variations appear. The response of single taxa to the environmental variations is neither contemporaneous nor uniform. However, when new climatic models set in, we can observe a tendency towards an early turnover. followed by a second phase. perhaps due to the stabilization of the new climatic model. of a near completion of the faunal renewal. The faunal variations which correspond to the Olivola and Tasso, Slivia and Isernia. Torre in Pietra and Vitinia F. U. could be an example of this. Relatively stationary periods where appearances and disappearances become rarer are likely to follow.

In the cases in which the appearances of the taxa are diachronical. setting a boundary for the biochrones becomes difficult. For example, **in** the case of the end of the Villafranchian faunas and the beginning of the Galerianan ones, we can see how the appearance of certain taxa, which in time directly or through their descendents make up the nucleus of the so-called "Galerian faunas". appear in the Italian faunas at an early date (e.g.*Equus altidens* and *Equus* ex gr. *E. bressanus/E. süssenbornensis* are already present in the Farneta F. U.). The difficulty in setting the boundary between the Villafranchian and Galerian faunas is further accentuated by the fact that the appearances of the single taxa do not seem to be contemporaneous in each Euro-Asian district.

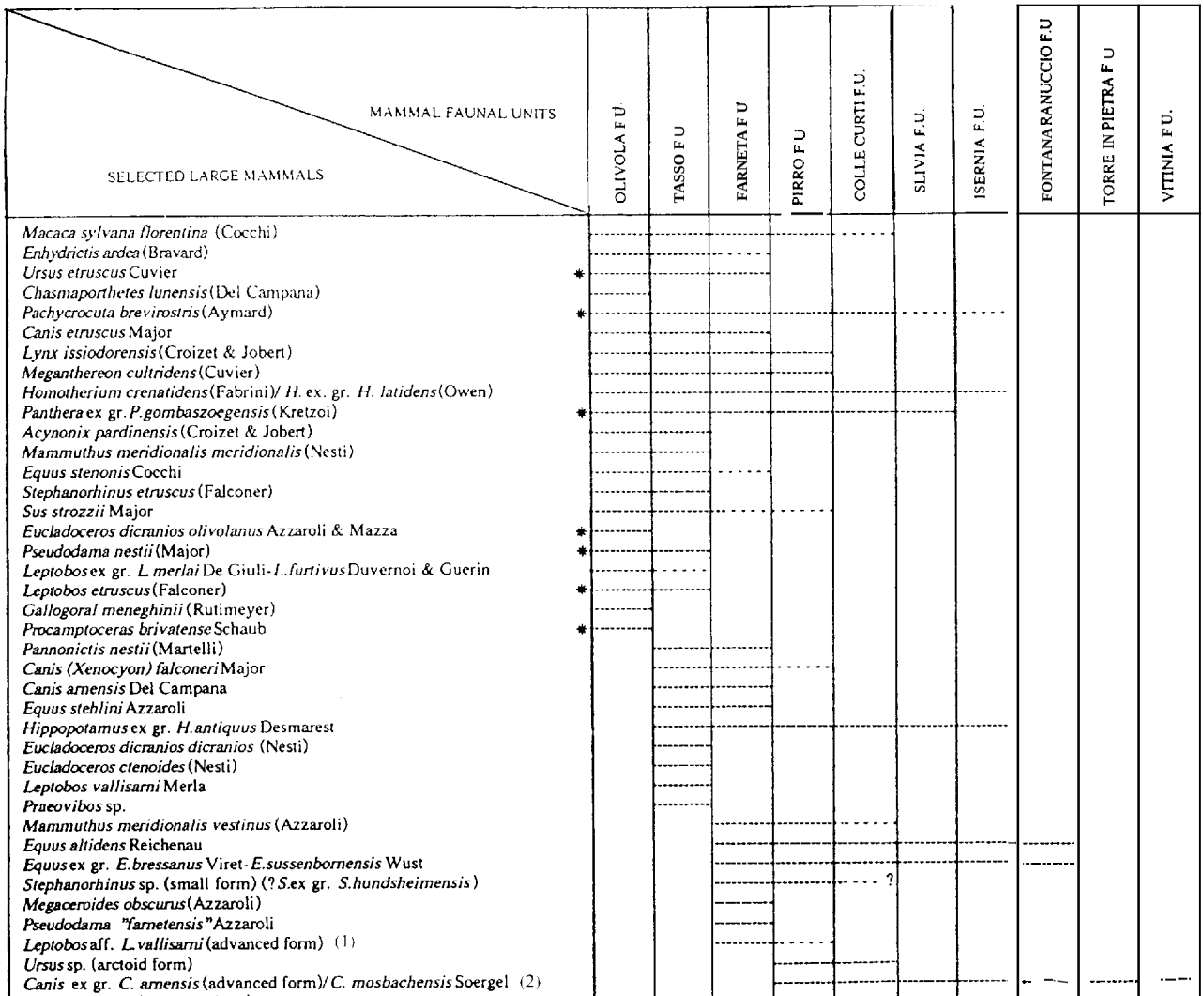
Limiting the problem to Italy, at least three hypotheses could be proposed (Table 1):

1) the beginning of the Galerian at the same time as the climatical crisis of the Great Glacial Age and therefore with the begining of the Middle Pleistocene. when the Italian mammalofaunas saw a consistent renewal. as found in the Slivia F. U.;

2) the institution of a new faunal complex, the Protogalerian (Caloi and Palombo, 1995, in press), covering the interval of the lower Pleistocene, preceding the Great Glacial Age. in which changes in the faunistical associations are not numerically significant. but in which a progressive appearance of various "Galerian elements" (F. U. of Farneta, Pirro and Colle Curti) occurs. The lower limit could coincide with the first occurrence of "galerian" equids in the Selvella local fauna, whereas the upper limit may possibly coincide with the disappearance of *M. (Allophaiomys)* and the turnover of the Slivia F.U.

3) the choice of a conventional marker for the beginning of the Galerian. such as *Megaceroides verticornis*, which appears **in** Italy at Colle Curti, in a fauna which is calibrated with the Jaramillo subchron.

Last of all. the number of extinctions and appearances associated in different ways in the single turnovers must be pointed out. Considering in the whole Olivola and Tasso F. U., new arrivals (16) and extinctions (12) are more or less equivalent in number (with a slight prevalence in the appearances). in the Torre in Pietra and Vitinia F. U.. There is a prevalence of appearances (9) to extinctions (only two), but a corisiderablc phase of extintion (6) characterized the Fontana Ranuccio F.U./Torre in Pietra F.U. passage. The greatest phase of extinction occurs in the last Glacial Age, during which there was a progressive disappearance of the hippopotami, elephantids, rhinocerotids, large carnivores, large artiodactyls of the plains, not to mention some boreal forms which in the coldest acmes had extended their territory to our peninsula.


MAMMAL FAUNAL UNITS
SELECTED LARGE MAMMALS
OLIVOLA F U
TASSO F U
FARNETA F U
PIRRO F U
COLLE CURTI F.U.
SLIVIA F.U.
ISERNIA F.U.
FONTANA RANUCCIO F.U
TORRE IN PIETRA F U
VITINIA F U.
Macaca sylvana florentina (Cocchi)
Enhydrictis ardea (Bravard)
Ursus etruscus Cuvier
Chasmaporthetes lunensis (Del Campana)
Pachycrocuta brevirostris (Aymard)
Canis etruscus Major
Lynx issiodorensis (Croizet & Jobert)
Megantereon cultridens (Cuvier)
Homotherium crenatidens (Fabrini)/ H. ex. gr. H. latidens (Owen)
Panthera ex gr. P.gombaszoegensis (Kretzoi)
Acynonix pardinensis (Croizet & Jobert)
Mammuthus meridionalis meridionalis (Nesti)
Equus stenonis Cocchi
Stephanorhinus etruscus (Falconer)
Sus strozzii Major
Eucladoceros dicranios olivolanus Azzaroli & Mazza
Pseudodama nestii (Major)
Leptobos ex gr. L. merlai De Giuli-L.furtivus Duvernoi & Guerin
Leptobos etruscus (Falconer)
Gallogoral meneghinii (Rutimeyer)
Procamptoceras brivatense Schaub
Pannonictis nestii (Martelli)
Canis (Xenocyon) falconeri Major
Canis arnensis Del Campana
Equus stehlini Azzaroli
Hippopotamus ex gr. H.antiquus Desmarest
Eucladoceros dicranios dicranios (Nesti)
Eucladoceros ctenoides (Nesti)
Leptobos vallisarni Merla
Praeovibos sp.
Mammuthus meridionalis vestinus (Azzaroli)
Equus altidens Reichenau
Equus ex gr. E.bressanus Viret-E.sussenbornensis Wust
Stephanorhinus sp. (small form) (?S.ex gr. S.hundsheimensis)
Megaceroides obscurus (Azzaroli)
Pseudodama "farnetensis" Azzaroli
Leptobos aff. L.vallisarni (advanced form) (1)
Ursus sp. (arctoid form)
Canis ex gr. C. arnensis (advanced form)/ C. mosbachensis Soergel (2)
Pseudodama sp (advanced form)
?

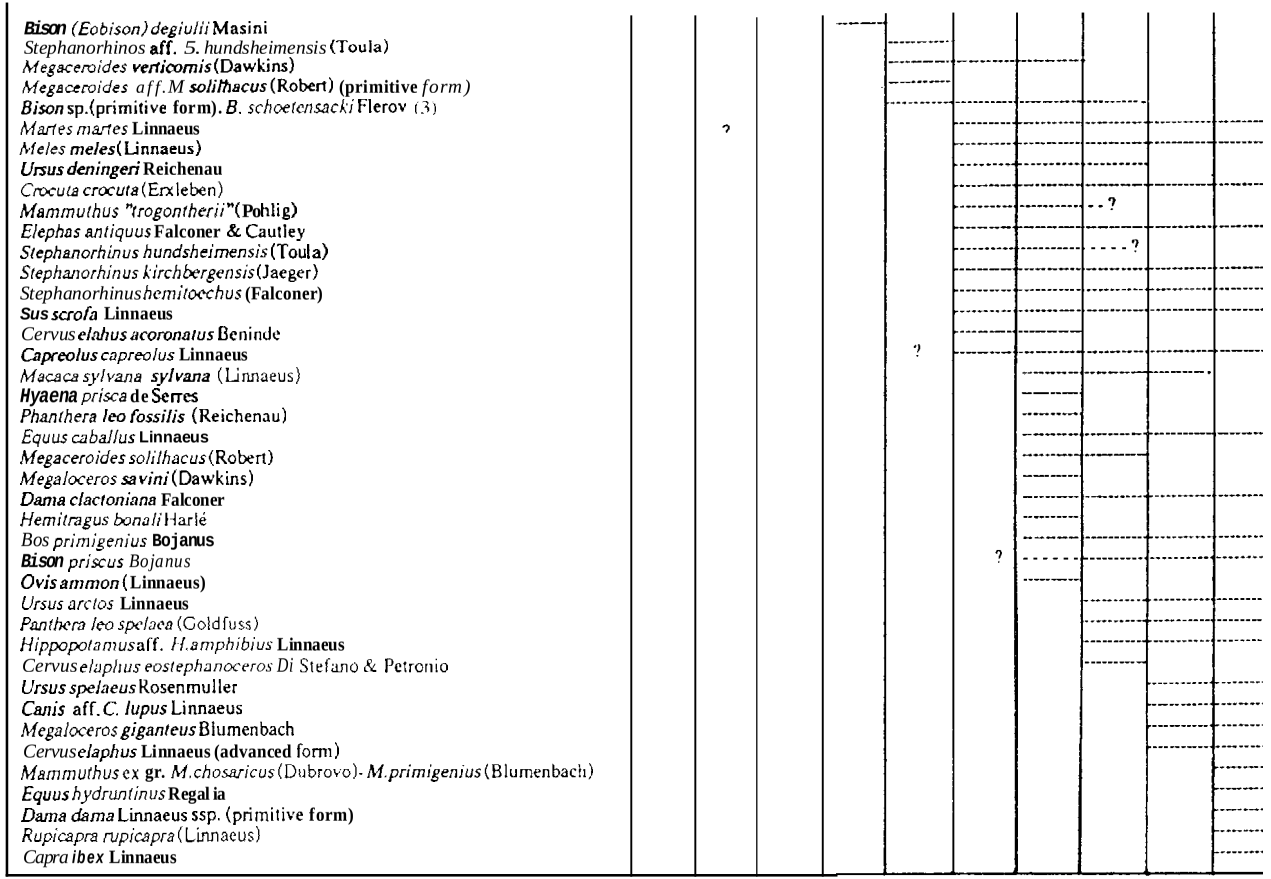


Table 2 - Biochronology of selected Early and Middle Pleistocene mammals in the Italian peninsula

———— occurrence: - - - - doubtful occurrence ; * = first occurrence in the Olivola F.U.

(1) A bivine with some affinities occur until Colle Curti F.U.

(2) In this group various forms of genus *Canis* of doubtful sistematic position are included

(3) A bison closely related to *B. schoetensacki* occurs in the Redicicoli mammal fauna, which may be tentatively referred to the Colle Curti F.U. (Caloi and Palombo, 1995b). The true *B. schoetensacki* firstly occurs in the Isernia F.U.

ADDENDA

After the presentation of this paper at the First ATIT Congress. the Italian vertebrates paleontologists of the AIQUA Working Group. during the XIX INQUA Congress in Berlin, August 1995, proposed setting the beginning of Galerian in coincidence with the appearance of *M. verticornis* and instituted the Aurelian for the Italian associalions of the late Middle and Late Plcistocene (Gliozzi et alii, 1997).

According to Abbazzi (Abbazzi L. 1995. *Megaceroides obscurus* from the Val di Chiana (Cava Liberatori, Tuscany, Central Italy. Farneta F.U.. Early Pleistocene). Remarks on the early evolution and systematic of *Megaceroides*. Boll.Soc. It., 34. 2). *Megaceroides obscurus* is the only large cervid present in the Italian faunal assemblage of Farneta F.U.

REFERENCES

Albianelli. A.. Coltorti. M.. Ficcarelli, G., Laurenzi, **M.**. Napoleone, G. and Torre, D.. 1993. An Early Galerian Fauna, sediments and geomorphological evidence from the Colfiorito area (Umbria-Marche Apennines). Abstracts, Symp.Quaternary stratigraphy in volcanic areas, Roma, 20-22 scttcmbrc 1993: 7

Ambrosctti. P., Bartolomei, G., De Giuli, C., Ficcaelli, G. and Torre, D., 1979. La hreccia ossifera di Slivia (Aurisina-Sistiana) nel Carso di Trieste. Boll.Soc.Paleont.It.. 18: 207-220.

Ambrosetti. P., Carboni. M. G.. Conti, M. A., Esu, D., Girotti **O.**.La Monica, G. B. and Parisi, G., 1987. Il Pliocenc c il Pleistocene inferiore del bacino del Fiumc Tcvcrc nell'Umbria meridionale. Geogr. Fis.Dinam. Quat.. 10: 10-33.

Ambrosetti. P.. Abbazzi, L.. Gentili, S., Masini, F. and Torre, D., (in prep.). *Microtus (Allophaiomys) chalinei* and other voles from the Early Pleistocene of Pietrafitta (Central Italy. Perugia).

Azzaroli, A. and Mazza, P., 1993. The cervid genus *Eucladoceros* in the early Pleistocene of Tuscany. Palaeontogr. Ital., 79: 43-100.

Bertini, A.. 1989. Nuovi dati palinologici sui sedimenti del grupo di Montevarchi (Valdarno Superiore). Informatore Botanico. 21: 253-261.

Biddittu, I, Cassoli. P. F.. Radicati di Brozolo, F., Scgrc. A.G.. Segre-Naldini, E. and Villa, I., 1979. Anagni a K:Ar dated Lower Middle Pleistocene site. Central Italy: preliminary report. Quaternaria, 21: 53-71.

Boeuf, O., 1990. Originalité et importance de la faune plio-pléistocène de hilhac aute-Loire, France).Quartarpalaontologie, 8: 13-28

Borselli V., Ficcarelli. G., Landucci, F.. Magnatti, M., Napoleonc. G. and Pambianchi. G.. 1988. Scgnalazione di mammiferi pleistocenici nell'area di Colfiorito (Appennino umbro-marchigiano) e valutazione della potenzialità del giacimento con metodi geofisici. Boll.Soc.Paleont.It., 27 (2): 253-257.

Borselli V. De Giuli, C.. Ficcarelli, G. and Mazzini. M.. 1980. Casa Frata: una località fossilifera del Villafranchiano Superiore presso Terranuova Bracciolini (Arezzo) nel Valdarno Superiorc. Boll.Soc. Pal.It., 19: 245-258.

Caloi. L. and Palombo, M. R.. 1995a. Biocronologia c paleoecologia delle mammalofaune del Pleistocene medio dell'Italia centrale. Studi Geologici Cainerti. 1994 (B): 503-514.

Caloi, L.. and Palombo M. **R.,** 1995b. Le mammalofaune del Pleistocene inferiore nell'Italia centrale. Studi Geologici Camerti, 1994(B): 487-501.

Caloi, L. and Palombo. M. R., 1996. Late Early Plcistoccnc mammal faunas of Italy: biochronological problem. Il Quaternario, 8(2): 391-402.

Caloi, L., Palombo. M. R., Zarlenga. F., in

press. Late Middle Pleistocene mammal faunas of Latium, stratigraphy and environment. Quaternary Int.

Coltorti M., Cremaschi, M., Delitala M. C.. Esu, D., Fornaseri, M.. Mc Pheffron, A., Nicoletti, M.. Van Otterloo, M.. Peretto, C., Sala, R., Schmidt, V. and Sevink, J.. 1982. Reversed magnetic polarity at Isernia La Pinetsa, a new lower paleolithic site in Central Italy. Nature, 300 (5888): 173-176.

Comborieu Nebout, N. and Vergnaud Grazzini, C.. 1991. Late Pliocene northern hemisphere glaciations, the continental and marine response in the central Mediterranean. Quaternary Sc. Kcv.. 10 : 319-334.

De Giuli. C., 1987. Late Villafranchian faunas of Italy: the Selvella-Local Fauna in the southern Chiana valley-Umbria. Palaeontogr. Ital., 74 (1986): 11-50.

De Giuli, C. and Torre, D., 1984. A microfauna with *Allophaiomys pliocaenicus* from Gargano, southern Italy. Palaeontogr. Ital., 73: 116-128.

De Giuli, C., Masini. F. and Torrc, D.. 1987. The Latest Villafranchian Faunas in Italy: the Pirro Nord fauna (Apricena. Gargano). Palaeontogr. Ital., 74 (1986): 51-62.

De Giuli, C., Masini. F. and Torre, D., 1990. The Latest Villafranchian Faunas in Italy: the Pirro Nord fauna (Apricena. Gargano). Quartarpalaontologic, X (1990): 29-34.

Di Stefano, G. and Petronio, C., 1992. Nuovc osservazioni su *Cervus elaphus acoronatus* Beninde del Pleistocene europeo. Boll.Soc.Pal.It., 31: 295-315.

Ficcarelli, G.. Magnatti, M. and Mazza, P.. 1990. Occurrence of *Microtus (Allophaiomys)* gr. *pliocaenicus* in the lacustrine basin of Colfiorito (Umbrian-Marchean Apcnninc), Central Italy. Boll.Soc. Paleont.It., 29 (1): 89-90.

Ficcarelli. G. and Silvestrini. M.. 1991. Biochronogical remarks on the Local Fauna of Colle Curti (Colfiorito Basin . Umbrian-Marchean Apennine, Central Italy). Roll. Soc. Paleont. It., 30 (2) : 197-200.

Follicri, M., Magri, D. and Sadori, L., 1986. Late Pleistocene *Zelkova* extinction in central Italy. New Phytologist, 103: 269-273.

Follieri, M.. Magri, D. and Sadori. L.. 1988. 250.000 pollen record from Valle di Castiglione (Roma). Pollen et Spores, 30 (3-4): 329-356.

Gliozzi, E., 1990. I terrazzi del Pleistocene superiore della penisola di Crotone (Calabria). Geol. Romana, 26 (1987); 17-79.

Gliozzi, E. Abbazi, L.. Ambrosetti, P.. Argenti, P., Azzaroli, A., Caloi, L.. Capasso Barbato. L., Di Stefano, G., Esu, D.. Ficcarelli, G., Girotti. O..Kotsakis, T., Masini, F.. Mazza. P.. Mezzabotta, C., Palombo, M. R., Petronio. C., Rook, L.. Sala, B.. Sardella. R., Zanalda, E., and Torrc, D., 1997. Biochronology of selected Mammals, Molluscs, Ostracods from the Middle Pliocene to the Late Pleistocene in Italy. The state of the art. Riv. It. Paleont. Stratigr., 103(3): 369-388.

Masini, F.. Rook. L.. Abbazzi. L., Ambrosetti. P.. Azzaroli. A., Ficcarelli. G., Gentile, S., Kotsakis, T., Sala . B. and Torre , D., 1994. Mammalian Faunas of Selected localities of Italy. Convcgno del AIQUA-CNR "Il significato del Villafranchiano nella stratigrafia del Plio-Pleistocene". Peveragno (CN)-Villafranca (AT). 20-24 giugno 1994.

Masini. F. and Santini, G., 1991. Microtus (Allophaiomys) (Arvicolidae, Rodentia. Mammalia) from Cava Pirro (Apricena, Gargano) and other Italian localities. Boll. Soc. Paleont. It.. 30 (3) : 355-380.

Masini, F. and Torre, D.. 1990. Review of the Villafranchian Arvicolids of Italy. Geologica Rorn., 26 (1987) : 127 -133.

Roebroeks, W. and Kolfschoten, T.. van., in press. The earliest occupation in Europe:

a reappraisal of artefactual and chronological evidence.

Rustioni, M. and Mazza, P.. 1991. Note sugli orsi quaternari dell'Italia. Studi Ecol. Quat., 1991; 149-161.

Thunncl. R., Williams, D.. Tappa, E., Rio, D. and Raffi, I., 1990. Pliocene-Pleistocene stable isotope record for Ocean Drilling Program Site 653. Tyrrhenian basin: implications for the paleoenvironmental history of the Mediterranean Sea. In Kastens K.A., Mascle J. et al.. Proceedings Ocean Drilling Program, Scientific Results. 107: 387-399.

Torre, D., Albianelli, A.. Azzaroli. A., Ficcarelli, G., Magi, M.. Napoleone, G. and Sagri, M., 1993. Paleomagnetic calibration of late Villafranchian mammalian fauna from the Upper Valdarno. central Italy. Mem.Soc. Geol. It.. 49 (1993): 335-344.

Vergnaud Grazzini. C., Saliège .J. F., Urrutiaguer. M. J. arid Iannace. A.. 1990. Oxygen and carbon isitope stratigraphy of ODP Hole 653A and Site 654: the Pliocene-Pleistocene glacial hystory recorded in the Tyrrhenian Basin (west Mediterranean). In Kastens K.A., Mascle J. et al.. Proceedings Ocean Drilling Program, Scientific Results, 107: 361-386.

Williams. D. F., Thunell, K. C.. Tappa , E., Rio, D. and Raffi, I., 1988. Chronology of the Pleistocene oxygen isotope record: 0-1.88 m.y. B.P. Palaeogeogr.. Palaeoclim., Palaeoecol.. 64: :221-240.

Zagwijn, W.H., 1992a. The beginning of the Ige Age in Europe and its major subdivisions. Quaternary Sci. Rev., 2: 538-591.

Zagwijn, W.H., 1992b. Migration of vegetation during the Quaternary in Europe. Courier Forsch. Inst. Senckenberg, 153: 9-20.

Zijderveld, J. D. A., Hilgen. F.J., Langereis, C.G.. Verhallen, P. J. J. M. and Zachariasse, W.J.. 1991. Integrated magnetostratigraphy and biostratigraphy **of** the upper Pliocene-lower Pleistocene from the Monte Singa and Crotone ai-eas in Calabria, Italy. Earth Plan. Sci. Letters, 107: 697-714.